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GROWTH RESPONSE OF SOME CULTIVARS OF BERMUDA GRASS (*CYANODON DACTYLON* L.) TO SALT STRESS

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Abstract

Turfgrasses range from extremely salt sensitive to highly salt tolerant. Turfgrass improvement for salinity tolerance requires reliable assessment for their adaptability to saline conditions, which vary among grasses. In the present study, four Bermuda grass cultivars -Tifway, Tifdwarf, Dacca and Khabbal (local ecotype) were assessed for salinity tolerance using half-strength Hoagland's solution culture system under green house conditions. The cultivars were exposed to five salinity levels viz., 2.4 (control) 50, 100, 150 and 200 mM NaCl). Increasing salt concentration in the nutrient media caused: (a) a reduction in number of stolons/plug, number of roots/plug, length of shoot, dry weights of root and shoot, turf quality, and potassium content in stolons, (b) increase in sodium and chloride content in stolons. Overall, cv. Tifway was found to be the most tolerant to salinity while Khabbal the most sensitive, among all four grass cultivars.

Introduction

Salinity is considered as one of the major factors that reduces plant growth in many regions of the world. Under saline conditions the plants are wilted and eventually die due to the high salt content even though there is ample soil moisture (Flowers & Colmer, 2008). Soil salinity is an important feature of landscape of arid countries especially where artificial irrigation is practiced (Affenzeller *et al*., 2009). The recent global climatic changes are expected to put severe pressure on water resources of many countries leading to non availability of irrigation water for landscape. Consequently secondary water resources are increasingly being used to irrigate landscape plants particularly large turf areas and unfortunately the problem of salinity is accentuated with light frequent irrigations that are typically utilized during turfgrass establishment.

In Pakistan, 3.44 million ha of land is salt affected while, in cities like Faisalabad, Sargodha and many other cities of Pakistan, increase used of saline water for irrigation is becoming a serious problem in providing either a playing surface or a green ground cover in golf courses, sports enterprises and home lawns. This situation needs an investigation to observe the response of various turf grasses to different salinity levels since differential salinity tolerance based on growth responses does exist among the turf grass species (Dudeck *et al*., 1983). Turfgrass species have varying levels of salt tolerance. Only a few species grow well under saline conditions. Zoysiagrass, Seashore Paspalum, Bermuda grass, and St. Augustine grass are the best warm-season turf species to grow if irrigation water is saline (Hameed & Ashraf, 2008; Hameed *et al*., 2008). Variations in salt tolerance among turf grasses have been demonstrated in many studies using hydroponic culture system (Marcum *et al*., 1998; Qian *et al*., 2000; Alshammary *et al*., 2004; Marcum, 2005; Naz *et al*., 2009). The major objectives of the present study were to determine the growth response of various turfgrass cultivars to salinity and select a variety that is most suitable for saline areas of Pakistan.

Material and Methods

Plant material: Four Bermuda grass cultivars named Tifway, Tifdwarf, Dacca and Khabbal (local ecotype) were used to test their response at different salinity levels. Plants of Tifway and Tifdwarf was taken from Royal palm Golf and Country Club, Lahore while, Dacca and Khabbal were taken from Floriculture experimental area, Institute of Horticultural Sciences, University of Agriculture Faisalabad (UAF). The collected grass cultivars were multiplied by growing them in the Floriculture area, UAF for the period of two months.

Plant culture and data collection: The research work was done in a greenhouse of Saline Agricultural Research Center, Institute of Soil and Environmental Sciences, UAF. Hoagland nutrient solution was used as a growth medium (Hoagland & Arnon, 1950) in 20 tubs (8 x 46 cm). Thermopole sheets were used to anchor the grass tillers subjected to nutrient solution. Each thermopole sheet had twelve holes at a distance of 12 x 12 cm. Grass plugs were planted in holes using a soft sponge material to hold plants. Three stolons per cultivar were used. The pH of the nutrient was maintained in the range of 6.0-6.5. Nutrient solution was provided with an air circulation system in order to avoid anaerobiosis of roots. Nutrient solution was changed after every fifteen days. After 45 days of growth in nutrient solution, roots and shoots of all cultivars were trimmed back to a length of about 3 cm and salinity treatments (2.4, 50, 100, 150 and 200 mM NaCl) were applied. After 45 days of growth period in saline solution, grasses were harvested to collect data. Treatment solutions were renewed three times at appropriate stages to make up deficiency of nutrients. Average diameter was measured with a vernier caliper, dry weight of root and shoot using an electric balance, length of shoot, number of stolons/plug, and turf quality were also measured. Na^+ and K^+ concentrations in stolons were measured by GDV flame photometer (Digiflame**,** 2000**,** GDV). Chloride (Cl^-) concentration in stolons was measured by a chloride analyzer (Model 926**,** Corning, Inc., Corning, NY). The limiting factor for Bermuda grasses is usually temperature, so two types of temperature were considered more important, i.e., air temperature and root temperature. In the months of October, November and December average day temperature was 29, 25 and 19 °C, and night temperature 14, 12 and 9°C. Similarly, in the three months average day and night temperatures of the growth medium had been 14, 11, 9°C and 9, 8, 6°C, respectively.

Data analysis: Data for different parameters were analyzed for significant differences using analysis of variance (ANOVA) (Steel *et al.*, 1997) and means compared at $p<0.05$ using the Duncan's Multiple Range test (Duncan, 1955).

Results and Discussion

Growth parameters: The response of all the cultivars to all the salt treatments was highly significant. Increase in concentration of NaCl in growth medium decreased the average length of shoot in all cultivars (Figs. 1 & 2), where the average maximum length of shoot was produced by cv. Dacca at all levels of salinity. The minimum length of shoot was recorded in Tifway. Salinity has a direct impact on shoot length along with leaf growth and development, which overall effects the photosynthesis (Schaan *et al.*, 2003).

Fig. 1. Growth of local cultivar Khabbal under salt stress.

Fig. 2. Growth of cultivar Tifway under salt stress.

Number of stolons contributes a lot in rate of coverage in grasses. There was a decreasing trend in number of stolons/plug with the increase in salinity (Fig. 3). Maximum number of stolons/plug was observed in Tifway, whereas Khabbal exhibited least number of stolons/plug. Variation in number of stolons was related to mortality of stolons due to salinity. Mortality of stolons/plug was related to the accumulation of more Na^+ and Cl^- ions that proved injurious for plant growth (Baumeister & Merten, 1981; Mansour & Hussein, 2002; Dudeck *et al*., 1983).

Response to salt stress regarding root dry weight varied significantly in all cultivars, which showed a reduction with increase in salinity level of the medium. Cultivar Khabbal produced the highest root dry weight than those of other cultivars at all salt levels (Fig. 3). However, root dry weight in Tifway showed relatively less reduction in this characteristic up to moderate salt level, i.e., 100 mM NaCl. Such reduction in root fresh weight might be due to a decrease in water uptake and osmotic potential under salt stress, which directly affects the growth and development of plants (Terry & Waldron, 1984; Riaz *et al*., 2010). Similar trend was observed by (De Costa and Zoysa, 1995) in soybean and rice, but in contrast, Hameed & Ashraf (2008) in *Cyndon dactylon* and Naz *et al*., (2009) in some arid zone grasses related high root dry weight to salinity tolerance. The overall reduction in dry weight of root was attributed due to toxic effect of salt and reduced nutrient availability due to salt stress in growth medium (Qadir & Shams 1997).

Shoot dry weight decreased with increase in external NaCl concentration (Fig. 3). The maximum shoot dry biomass was produced by Tifway at all levels of salinity, while the minimum by Dacca. This decrease in shoot dry weight could be due to shrinkage of cellular contents, reduced growth, development, and differentiation of tissues and disturbed avoidance mechanism as described earlier in different plant species under salt stress (Kent & Lauchli, 1985; Suplick-ploense *et al*., 2002; Munns & Tester, 2008). Salinity effects the growth of plants, which reduces metabolite synthesis and ultimately decreases dry weight of shoot (Cheesman, 1988).

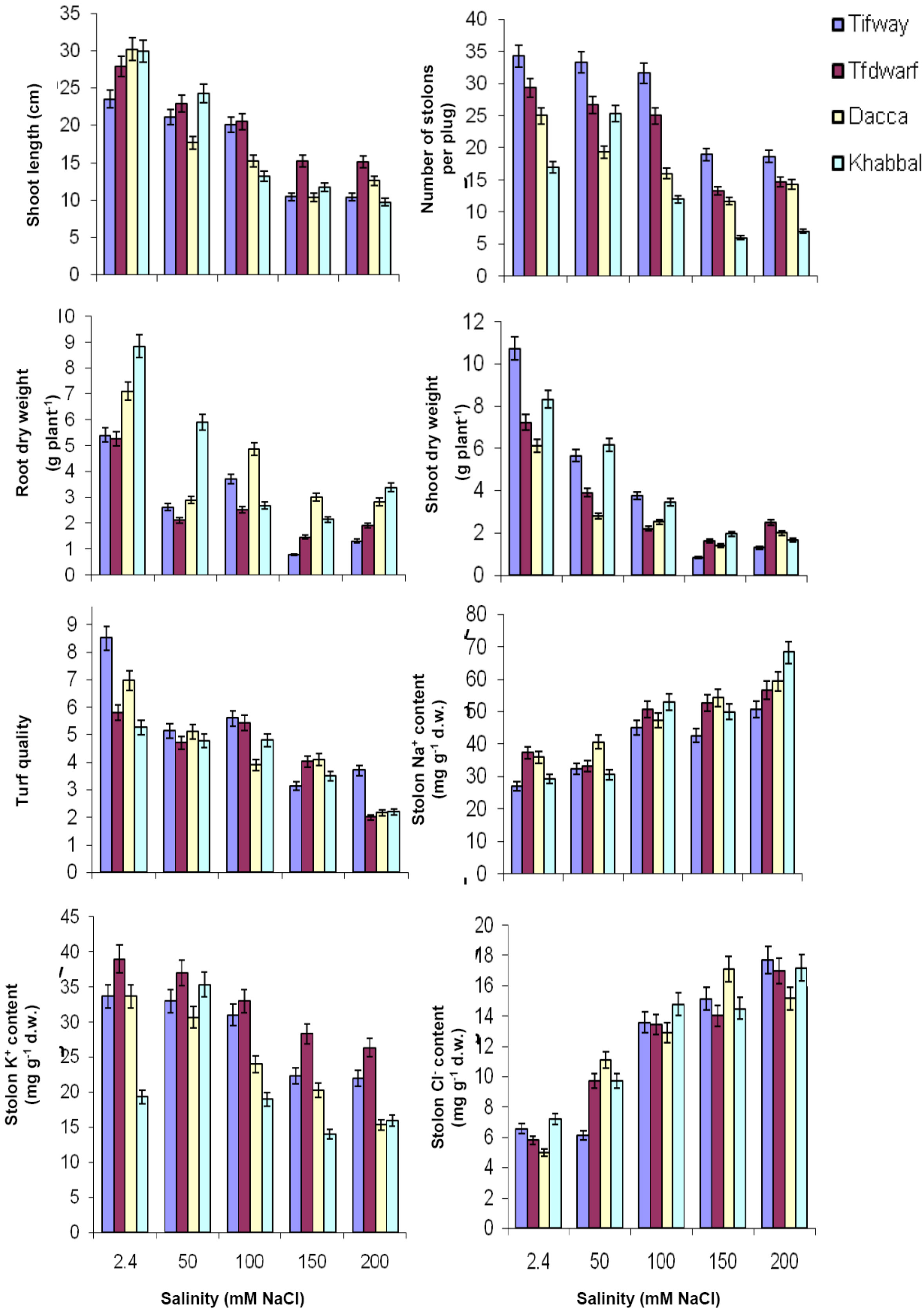

Fig. 3. Some morpho-physiological characteristics in Bermuda grass cultivars subjected to salt stress in hydroponic culture medium (means ± SE).

Regarding the quality of turf present results reflected that quality was decreased with the increase in salinity. However, in selected cultivars, Tifway produced the best quality turf, whereas, Khabbal produced the inferior quality at higher salinity levels (Fig. 3). The turf quality was probably affected by burning of tissues due to absorption of high concentration of salts and imbalance of Na^+: K^+ across the cell membrane (Brugnoli & Lauteri, 1991). These results are in confirmation with the findings of Dean *et al*., (1996).

Physiological parameters: Among physiological parameters more Na^+ was accumulated in stolons with increase in salinity, whereas, the maximum Na^+ concentration was observed in cultivar Dacca followed by that in Khabbal and Tifdwarf at all levels of salinity (Fig. 3). An increase in Na^+ concentration in stolons may attribute to induced accumulation of Na^+ that is the requirement of plants for osmotic adjustment (Ashraf & Naqvi, 1991; Hameed & Ashraf, 2008; Colmer & Flowers, 2008).

In contrast to Na^+, K^+ concentration decreased as salinity levels increased. In comparison, the maximum K^+ concentration was observed in Tifdwarf, while Khabbal showed the minimum K^+ concentration in stolons (Fig. 3). The decreased K^+ concentration under saline condition may be attributed to the antagonistic relationship of Na^+ and K^+ (Shukla & Mukhi, 1979; Ashraf, 2004; Munns & Tester, 2008).

Chloride (Cl^-) concentration increased in stolons like Na^+ with increase in salinity level in all cultivars (Fig. 3), where maximum Cl^- concentration was recorded in Khabbal. The increase in Cl^- concentration was associated with direct exposure of roots in the saline medium that contain more Cl^- ions (Ashraf & Harris, 2004).

Conclusion

On the basis of different growth and physiological parameters, tolerance level different cultivars of Bermuda grass to salinity stress can be rated as: Tifway > Tifdwarf > Dacca >Khabbal.

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